



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/691,540	10/24/2003	Kensaku Motoki	33035M0341	6887

441 7590 04/05/2005

SMITH, GAMBRELL & RUSSELL, LLP
1850 M STREET, N.W., SUITE 800
WASHINGTON, DC 20036

EXAMINER

SONG, MATTHEW J

ART UNIT	PAPER NUMBER
----------	--------------

1722

DATE MAILED: 04/05/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/691,540

Applicant(s)

MOTOKI ET AL.

Examiner

Matthew J Song

Art Unit

1722

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 April 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-7,13,16,17,20,25,26,29,30 and 34-37 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-7,13,16,17,20,25,26,29,30 and 34-37 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☒ Certified copies of the priority documents have been received in Application No. 09/560,818.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 4/1/04;10/24/03.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 16, 17, 25 and 26 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 16 recites, "a plurality of said opening windows of said mask layer are arranged with a pitch L" in lines 2-3. "L" is not defined; therefore indefinite, likewise for claim 17, 25, and 26.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1, 2 and 4 are rejected under 35 U.S.C. 102(e) as being anticipated by Mauk (US 5,828,088).

In a method of epitaxial lateral overgrowth, note entire reference, Mauk discloses a semiconductor substrate of GaAs is masked with a metal, dielectric or multilayer combination of

Art Unit: 1722

metals, semiconductors and/or dielectrics (col 5, ln 15-67). Mauk also discloses an epitaxial layer overgrowth process and the mask must be compatible with epitaxial lateral overgrowth of gallium nitride (col 6, ln 1-20). Mauk also discloses the extension of the process to other III-V and II-VI compound semiconductors is straight forward (col 7, ln 40-50). Mauk also discloses the epitaxial layer growing on the mask and the mask layer having a plurality of opening windows disposed separate from each other (Fig 3). Mauk also discloses the alignment of stripes on the wafer surface is also an important factor in optimizing the lateral overgrowth and optimization of stripe opening alignments are on other crystallographic orientations and other substrate materials (col 5, ln 55-67).

Referring to claim 2, Mauk discloses an epitaxial layer on the substrate supporting the mask layer (Fig 3), this reads on applicant's buffer layer.

Referring to claim 4, Mauk discloses the mask is patterned into stripes (col 5, ln 35-65).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out

Art Unit: 1722

the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1, 2 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Usui et al ("Thick GaN Epitaxial Growth with Low Dislocation Density by Hydride Vapor Phase Epitaxy") or Zheleva et al ("Dislocation density reduction via lateral epitaxy in selectively grown GaN structures") in view of Tischler et al (US 5,679,152).

In a method of GaN growth on a patterned substrate, note entire reference, Usui et al discloses a thick GaN layer was grown on a sapphire substrate without cracks. Usui et al also discloses growing a GaN buffer layer, forming a SiO₂ film on the buffer layer, patterning the buffer layer in window stripes with a period of 7 μm aligned along the <11-20> direction of the GaN layer (pg L899 and Fig 1). Usui et al also discloses the overgrowth of GaN proceeding on the mask, with the facets keeping their shape and the coalescence with neighboring facets (pg L900 and Fig 3 (c)). Usui et al also discloses the mask width was varied from 1 to 4 μm while the stripe period remained at 7 μm and this change affected the growth very little. Usui et al also discloses an 80 μm thick GaN layer was separated from a sapphire substrate (L901).

In a method of lateral epitaxy of GaN on a patterned substrate, note entire reference, Zheleva et al discloses an AlN layer is formed on a SiC substrate and a SiO₂ layer is patterned to contain circular windows and striped windows (pg 2472). Zheleva et al also discloses GaN grows vertically and laterally over the mask from the material which emerges over the windows (pg 2473-2474 and Fig 3), this reads on applicant's growing on the mask. Zheleva et al also

Art Unit: 1722

discloses homoepitaxial growth of GaN pyramids and stripes, this reads on applicant's epitaxial layer growing step (Abstract). Zheleva et al also discloses making a nearly defect free single crystal GaN (pg 2474). Zheleva et al also discloses a SiO₂ layer formed on a GaN/AlN/SiC structure (Fig 3), where GaN reads on applicant's buffer layer.

Usui et al or Zheleva et al do not teach a GaAs substrate.

In a method of making a GaN single crystal, note entire reference, Tischler et al teaches providing a substrate of crystalline material having a surface, which is epitaxially compatible with GaN, depositing a layer of GaN over the substrate and removing the substrate. Tischler et al also teaches silicon carbide, gallium arsenide and sapphire are examples of suitable substrates of crystalline material (col 2, ln 25-50), this is a teaching that SiC, GaAs and Sapphire are equivalents. Tischler et al also discloses one or more intermediate layers may serve as a buffer layer to enhance the crystallinity or other characteristics of the GaN layer (col 2, ln 50-55).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Usui et al or Zheleva et al by using a GaAs substrate for GaN growth as taught by Tischler et al because selection of a known material based on its suitability for its intended purpose is held to be obvious (MPEP 2144.07) and substitution of known equivalents for the same purpose is held to be obvious (MPEP 2144.06).

6. Claims 1, 2, 4 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Usui et al ("Thick GaN Epitaxial Growth with Low Dislocation Density by Hydride Vapor Phase Epitaxy") or Zheleva et al ("Dislocation density reduction via lateral epitaxy in selectively grown GaN structures") in view of Shakuda (US 5,838,029).

Art Unit: 1722

Usui et al or Zheleva et al teach all of the limitation of claim 1, as discussed previously, except Usui et al or Zheleva et al do not teach a GaAs substrate.

In a method of making GaN, note entire reference, Shakuda teaches a single crystal substrate of GaAs single crystal is used because its lattice constant is more approximate to that of gallium nitride type semiconductors, thus minimizing distortion on the semiconductor layers (col 10, ln 10-30). Shakuda also teaches the deposition of a low temperature buffer 2 and a high temperature buffer layer 3. Shakuda also discloses the substrate and the low temperature buffer layer are then removed by abrading mechanically or chemically at their rear surface (col 10, ln 25-65).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Usui et al or Zheleva et al by using a GaAs substrate because GaAs has a lattice constant more approximate GaN, thereby improving quality, as taught by Shakuda.

7. Claims 5-6 16-17, 20, 25, 26 and 29-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Usui et al ("Thick GaN Epitaxial Growth with Low Dislocation Density by Hydride Vapor Phase Epitaxy") or Zheleva et al ("Dislocation density reduction via lateral epitaxy in selectively grown GaN structures") in view of Tischler et al (US 5,679,152) or Shakuda (US 5,838,029) as applied to claims 1, 2 and 4 above, and further in view of Mauk (US 5,828,088).

The combination of Usui et al and Tischler et al or the combination of Usui et al and Shakuda teach all of the limitations of claim 5, as discussed previously, except the claimed direction the stripe windows extend.

The combination of Zheleva et al and Tischler et al or the combination of Zheleva et al and Shakuda teach all of the limitations of claims 5 and 6, as discussed previously, except the claimed direction the stripe windows extend and the claimed mask width.

In a method of epitaxial lateral overgrowth, note entire reference, Mauk teaches a semiconductor substrate of GaAs is masked with a metal, dielectric or multilayer combination of metals, semiconductors and/or dielectrics (col 5, ln 15-67). Mauk also teaches an epitaxial layer overgrowth process and the mask must be compatible with epitaxial lateral overgrowth of gallium nitride (col 6, ln 1-20). Mauk also teaches the extension of the process to other III-V and II-VI compound semiconductors is straight forward (col 7, ln 40-50). Mauk also teaches the epitaxial layer growing on the mask and the mask layer having a plurality of opening windows disposed separate from each other (Fig 3). Mauk also teaches the alignment of stripes on the wafer surface is also an important factor in optimizing the lateral overgrowth and optimization of stripe opening alignments on other crystallographic orientations and other substrate materials (col 5, ln 55-67), this is a teaching that the stripe direction is a result effective variable.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Usui et al and Tischler et al or the combination of Zheleva et al and Tischler et al or the combination of Usui et al and Shakuda or the combination of Zheleva et al and Shakuda by optimizing the stripe direction to obtain the claimed direction by conducting routine experimentation (MPEP 2144.05) because stripe direction is a result effective variable, as taught by Mauk.

Referring to claims 5-6, the combination of Usui et al and Tischler et al or the combination of Usui et al and Shakuda teach a period of 7 μm and a SiO_2 mask width of 1-4 μm ,

Art Unit: 1722

which is a window width of 3-6 μm . Overlapping ranges are held to be obvious (MPEP 2144.05). The combination of Zheleva et al and Tischler et al or the combination of Zheleva and Shakuda teaches striped windows of 3 and 5 μm (pg 2472, col 1) and the final size of the base GaN pyramids as well as their height depend on the window to mask ratios (pg 2472, col 2), this is a teaching that the mask width is a result effective variable. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Zheleva et al, Tischler et al and Mauk or the combination of Zheleva, Shakuda and Mauk by optimizing the mask width by conducting routine experimentation to obtain the claimed mask width (MPEP 2144.05).

Referring to claims 16-17, 20, 25, 26 and 29-30, the combination of Usui et al, Tischler et al and Mauk or the combination of Zheleva et al, Tischler et al and Mauk or the combination of Usui et al, Shakuda and Mauk or the combination of Zheleva et al, Shakuda and Mauk do not teach the claimed mask and window arrangement. However, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Usui et al, Tischler et al and Mauk or the combination of Zheleva et al, Tischler et al and Mauk or the combination of Usui et al, Shakuda and Mauk or the combination of Zheleva et al, Shakuda and Mauk by optimizing the stripe direction and pitch to obtain the claimed direction and pattern by conducting routine experimentation (MPEP 2144.05) because stripe direction is a result effective variable, as taught by Mauk.

Referring to claim 25, 26, 29 and 30, the combination of Usui et al, Tischler et al and Mauk or the combination of Zheleva et al, Tischler et al and Mauk or the combination of Usui et al, Shakuda and Mauk or the combination of Zheleva et al, Shakuda and Mauk does not teach the

Art Unit: 1722

shape of the opening are rectangular windows in an oblong form or hexagonal windows.

Different patterns of mask layers used in the selective growth of GaN are known in the art, such as rectangular and hexagonal patterns, as evidenced by Kitamura et al (“Fabrication of GaN Hexagonal Pyramids on Dot-Patterned GaN/Sapphire Substrates via Selective Metalorganic Vapor phase epitaxy”) in Fig 1 and Shibata et al (“HVPE growth and properties of a high quality GaN bulk single crystal using selective area growth”) in Fig 2. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Usui et al, Tischler et al and Mauk or the combination of Zheleva et al, Tischler et al and Mauk or the combination of Usui et al, Shakuda and Mauk or the combination of Zheleva et al, Shakuda and Mauk by using a mask pattern with the claimed shape because changes in shape are held to be obvious (MPEP 2144.04) and the claimed shapes are conventionally used in the selective growth of GaN.

8. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Usui et al (“Thick GaN Epitaxial Growth with Low Dislocation Density by Hydride Vapor Phase Epitaxy”) or Zheleva et al (“Dislocation density reduction via lateral epitaxy in selectively grown GaN structures”) in view of Tischler et al (US 5,679,152) or Shakuda (US 5,838,029) as applied to claims 1 and 2 above, and further in view of Tadatomo et al (US 5,770,887).

The combination of Usui et al and Tischler et al or the combination of Usui et al and Shakuda or the combination of Zheleva et al and Tischler et al or the combination of Zheleva et al and Shakuda teaches all of the limitations of claim 13 including forming a buffer layer using OMVPE and MOVPE (Usui pg L899 col 2 and Zheleva pg 2472 col 1), as discussed previously,

Art Unit: 1722

except the combination of Usui et al and Tischler et al or the combination of Usui et al and Shakuda or the combination of Zheleva et al and Tischler et al or the combination of Zheleva et al and Shakuda does not teach forming the buffer using hydride vapor phase epitaxy.

In a method of making GaN, note entire reference, Tadamoto et al teaches permitted epitaxial growth of material to form GaN single crystal and buffer layer include vapor phase epitaxy, hydride vapor phase epitaxy, and metal organic vapor phase epitaxy (col 4, ln 35-40, col 1, ln 40-45 and col 2, ln 10-25), this is a teaching MOVPE and HVPE are equivalent methods of forming buffer layers.

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Usui et al and Tischler et al or the combination of Usui et al and Shakuda or the combination of Zheleva et al and Tischler et al or the combination of Zheleva et al and Shakuda by using HVPE instead of MOVPE because Tadamoto et al teaches HVPE and MOVPE are equivalent methods of forming GaN buffer layer and substitution of known equivalents for the same purpose is held to be obvious (MPEP 2144.06).

9. Claims 34 and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Usui et al ("Thick GaN Epitaxial Growth with Low Dislocation Density by Hydride Vapor Phase Epitaxy") or Zheleva et al ("Dislocation density reduction via lateral epitaxy in selectively grown GaN structures") in view of Tischler et al (US 5,679,152) or Shakuda (US 5,838,029) as applied to claims 1 and 2 above, and further in view of IBM (Abstract of "Method of Producing Gallium nitride Boules for Processing into Substrates").

Art Unit: 1722

The combination of Usui et al and Tischler et al or the combination of Usui et al and Shakuda or the combination of Zheleva et al and Tischler et al or the combination of Zheleva et al and Shakuda teaches all of the limitations of claim 34, as discussed previously, except forming an ingot and cutting the ingot into a plurality of sheets.

In a method of making GaN substrates, note entire reference, IBM teaches forming GaN boules using halide vapor phase epitaxy, this reads on applicant's ingot. IBM also teaches the boule is diced into numerous GaN substrates which would be available at reasonable prices for GaN based optoelectronic device growth (Disclosure), this reads on applicant's cutting step into a plurality of sheets. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Usui et al and Tischler et al or the combination of Usui et al and Shakuda or the combination of Zheleva et al and Tischler et al or the combination of Zheleva et al and Shakuda with IBM's method of forming GaN substrates to form useful substrates at a reasonable price.

10. Claims 35 and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Usui et al ("Thick GaN Epitaxial Growth with Low Dislocation Density by Hydride Vapor Phase Epitaxy") or Zheleva et al ("Dislocation density reduction via lateral epitaxy in selectively grown GaN structures") in view of Tischler et al (US 5,679,152) or Shakuda (US 5,838,029) and further in view of IBM ("Method of Producing Gallium nitride Boules for Processing into Substrates") as applied to claims 34 and 36 above, and further in view of Inoue (US 5,182,233)

The combination of Usui et al, Tischler et al and IBM or the combination of Usui et al, Shakuda and IBM or the combination of Zheleva et al, Tischler et al and IBM or the combination

Art Unit: 1722

of Zheleva et al, Shakuda and IBM teaches all of the limitations of claim 34, as discussed previously, except a cleaving step of cleaving the ingot into a plurality of sheets.

In a method of dicing crystals, note entire reference, Inoue teaches a compound semiconductor wafer formed of a single crystal is diced along a cleavage plane since along this plane the single crystal easily splits (col 1, ln10-40), this reads on applicant's cleaving step. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Usui et al, Tischler et al and IBM or the combination of Usui et al, Shakuda and IBM or the combination of Zheleva et al, Tischler et al and IBM or the combination of Zheleva et al, Shakuda and IBM by dicing along the cleaving plane, as taught by Inoue, because the single crystal easily cracks along the cleavage plane.

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Nam et al ("Lateral epitaxy of low defect density GaN layer via organometallic vapor phase epitaxy") teaches overgrowth of GaN on a SiO₂ mask (Fig 1 and Abstract).

Sakai et al ("Defect structure in selectively grown GaN films with low threading dislocation density") teaches overgrowth of GaN on a SiO₂ mask and GaN buffer layer (Fig 1 and Abstract).

Kitamura et al ("Fabrication of GaN Hexagonal Pyramids on Dot-Patterned GaN/Sapphire Substrates via Selective Metalorganic Vapor phase epitaxy") teaches dot-

Art Unit: 1722

patterned windows in a SiO₂ mask with hexagons with a width of 5 mm and a spacing of 10 mm in the <11-20> direction (Experimental Procedure and Fig 1).

Shibata et al ("HVPE growth and properties of a high quality GaN bulk single crystal using selective area growth") teaches epitaxial lateral overgrowth of GaN on a SiO₂ mask and the mask is patterned with rectangular windows (Abstract and Fig 2).

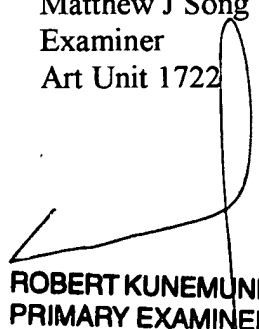
12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on 571-272-1137. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

MJS
March 31, 2005

Matthew J Song
Examiner
Art Unit 1722



ROBERT KUNEMUND
PRIMARY EXAMINER